ENGINEERING-EDUCATION

Bulletin of the
Society for the Promotion of Engineering Education

Vol. IX LANCASTER, PA., SEPTEMBER, 1918 No. 1

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A UNIQUE OPPORTUNITY.

TO ALL INTENTS AND PURPOSES THE WAR DEPARTMENT THROUGH ITS COMMITTEE ON EDUCATION AND SPECIAL TRAINING TAKES CHARGE OF COLLEGES ON OCTOBER 1, WHEN ALL PHYSICALLY FIT MALE STUDENTS EIGHTEEN YEARS OR OVER WILL BE MEMBERS OF THE STUDENT ARMY TRAINING CORPS.

THIS MEANS THAT THE OLD COURSES OF STUDY ARE PRACTICALLY ABOLISHED AND THERE ARE SUBSTITUTED SHORT INTENSIVE COURSES WHICH WILL FIT MEN FOR SPECIFIC DUTIES WITH THE ARMY.

THE CHANGE WHICH THIS INVOLVES PROVIDES THE ENGINEERING TEACHER WITH THE GREATEST OPPORTUNITY EVER PRESENTED TO TEACHERS. MODIFICATIONS IN THE CURRICULUM, CHANGES IN METHODS OF TEACHING, INTRODUCTION OF NEW MATERIAL CAN NOW BE MADE AT ONCE WHILE IN TIMES OF PEACE IT WOULD REQUIRE YEARS OF AGITATION TO ACCOMPLISH EVEN A SMALL FRACTION OF THESE CHANGES.

THE OPPORTUNITY OPEN TO TEACHERS OF ENGINEERING IS EQUALLY OPEN TO THIS SOCIETY AS AN ORGANIZATION OF SUCH TEACHERS.

IT IS INDEED MOST FORTUNATE THAT THE JOINT COMMITTEE OF THIS AND OTHER ENGINEERING SOCIETIES SHOULD HAVE MADE ITS FINAL REPORT AT THIS TIME. THIS REPORT PRESENTS IN A COMPREHENSIVE WAY WHAT HAS BEEN ACCOMPLISHED BY ENGINEERING TEACHERS UP TO THE PRESENT TIME AND SUGGESTS THOSE MODIFICATIONS AND CHANGES WHICH APPEAR TO BE MOST NECESSARY

TO MEET THE NEEDS OF INDUSTRY FOR THOROUGHLY TRAINED MEN IN NORMAL TIMES.

THE TEACHERS OF ENGINEERING WHO HAVE BEEN IN CONTACT WITH THE TECHNICAL TRAINING CORPS ESTABLISHED LAST APRIL IN DIFFERENT SCHOOLS HAVE LEARNED MANY THINGS OF VALUE IN TRAINING MEN FOR SPECIFIC INDUSTRIES. THE NEW COURSE NOW BEING ESTABLISHED BY THE WAR DEPARTMENT SHOULD BE USED BY THE TEACHER OF ENGINEERING AS A LABORATORY IN WHICH IDEAS CAN BE WORKED OUT TO A SUCCESSFUL FORM OF INSTRUCTION.

THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION IS AN ORGANIZATION WITH A UNIQUE OPPORTUNITY TO COÖRDINATE THE BEST WHICH CAN BE DEVELOPED AND PREPARE THE WAY FOR THE ADOPTION OF THESE IN THE GREAT RECONSTRUCTION PERIOD WHICH IS TO FOLLOW THE WAR.

AS A MEMBER OF THIS SOCIETY IT IS YOUR DUTY TO DEVELOP AND PUBLISH FOR THE BENEFIT OF OTHERS, THOSE IDEAS WHICH MAY IN ANY WAY BE HELPFUL IN THIS CRISIS.

SUGGESTIONS FOR CONSIDERATION.

F. H. NEWELL,

Professor of Civil Engineering, University of Illinois.

The following suggestions are offered in the hopes of arousing discussion, either here or later, of some of the fundamentals of our vocation. Viewing it in a large way, the first impression of the business of engineering education had by an engineer coming from so-called "practical life" is the absence of definite plan and of what are usually termed "efficiency" methods. There seems to be little attempt at economy of effort or of time either for the students or for the instructors. This condition arises presumably from lack of general agreement as to what we are really doing or from a failure to obtain clear conceptions as to the objects we are trying to attain. There seems to be little or no coöperation effort in a large way among instructors of engineering nor coördination among the various divisions of instruction; little or none of the well-organized team play so essential to success in our highly developed business or industrial life in which our students are soon to engage.

In the present crisis there is special need of clarifying and re-stating our ideals. To stimulate such action this condensed abstract is offered.

1. We are in a war in which the whole world is concerned.
2. This war in magnitude, intensity and destructiveness exceeds every other calamity.
3. It is likely to continue indefinitely with increasing destructiveness.
4. It is not a war of brute strength, but of engineering devices.
5. The side more likely to win is that which most quickly

invents and successfully utilizes various engineering devices. Time is an essential element.

6. To invent and to successfully utilize these devices more and more engineers are needed.

7. Whenever the war terminates there will be additional needs for engineering skill to repair the destruction wrought.

8. The rapid changes which are taking place in all affairs are being accompanied by equally far reaching changes in engineering methods.

9. These changes are of supreme concern in engineering education.

10. Educational methods should be quickly and effectively modified to anticipate or meet the demands of this new world of experience and ideals.

11. The government of the United States and many of the larger industries, connected directly or indirectly with the war, are calling for young engineers qualified to meet modern needs.

12. It is the business of the members of the Society for the Promotion of Engineering Education to manufacture young engineers from the raw materials.

13. It is important to do this as rapidly and effectively as possible, to begin now to increase the speed.

14. If the above statements are correct, it is our duty to lose no time in this important matter; but first we may ask

15. What is the Society for the Promotion of Engineering Education and what are its objects?

16. The constitution does not state any object; this must be inferred from the name and character of membership.

17. The membership comprises those persons who occupy or have occupied responsible positions in the work of engineering instruction, together with engineering practitioners and others interested in engineering education.

18. These members are brought together to promote engineering education. Are we doing it? To answer this we must agree as to what is included in "promotion."

19. Promotion, according to the dictionary, is to contribute to the growth, enlargement or prosperity, to encourage, to advance, as "to promote learning."

20. There is also a somewhat peculiar secondary meaning in American usage in that to *promote* any enterprise implies doing it with vigor and with the full use of all resources available regardless of consequences.

21. In the full sense are we really *promoting* engineering education? Are we contributing to its growth, to its enlargement, are we advancing it or is the rapid evolution of engineering methods dragging us with lagging feet in its train?

22. To promote any enterpise of the kind we must have

(*a*) materials,

(*b*) methods and

(*c*) men.

Are we advancing in each of these?

23. In (*a*) materials we are falling behind in the sense that the materials we work upon are young men. We have a fewer number each month. Are we using our resources effeffectively to get young men?

24. As a rule engineering colleges have pursued a dignified course and have not gone in an active, businesslike way into the high schools, or into "the high-ways and by-ways" to get needed material.

25. Are we doing our full duty if we do not exhaust every reasonable, and some unreasonable, means to let the grown boys know of the opportunities offered in engineering education and the needs of the nation? Are we truly promoting our work unless we do this?

26. After getting the students, are we using our full efforts to keep the best of these in college by urging the adoption or improvement of a system of detailing the enlisted men to intensive college training until they graduate?

27. In (*b*) methods we are less derelict; we have devoted most of our energies to discussion of these—but have we really

kept up with the new generation and are we actually putting into practice the theories which we are discussing?

28. In our present methods—a relic of the scholastic past,—are we not wasting time of the students and instructors in lost motion—in non-essentials, in vacations, etc.? By speeding up can we not accomplish in three years all we are now trying to do in four years?

29. In (*c*) *men* are we keeping up? To get and keep good instructors we must see that they have more than a bare living wage. Are we doing this? Are we not keeping as instructors the rejects from better paid engineering work?

30. The depreciation in purchasing power of gold is such that salaries of say $1,600 today are equivalent to not much more than $1,000 in a former decade. Our instructors with increased experience are getting less than in former years. What are we doing to promote engineering education in keeping those necessary men?

31. In this day and crisis in human affairs we are expected to try to be 100 per cent. efficient; are we doing it, or are we presenting an attitude of apology for occupying the time and space which might be better used?

32. In conclusion to "promote" engineering education we should concentrate on effective schemes for

(*a*) More materials—more students to be attracted and held.

(*b*) Better methods—less wasted time.

(*c*) Better men—more pay for instructors to keep up with past salaries and to prevent the better men from going out of educational work.

In the consideration of some of the items just given—comments have been made in conservation. Notably President Charles S. Howe of Case School of Applied Science, referring to the need of getting more materials to work upon (paragraph 23) has told how he has already initiated a thorough canvass of high-school students. The success of this can be ascertained only after the beginning of next winter's work.

On the whole the persons who have discussed such efforts have seemed to think that they are well worth attempting. Moreover under the conditions of modern life, it has been found that every similar enterprise must conduct well-planned publicity of advertising campaigns to secure an adequate supply of the material upon which to work.

In November, 1917, Prof. H. H. Jordan, assistant dean of the College of Engineering, University of Illinois, secured from 297 students in the freshman engineering class replies to questions intended to bring out the reasons why they came to the university and also as to why they chose engineering instead of some other college.

The answers indicate clearly that the students, in their own minds at least, were convinced that they had made the decision to enter the college without much help from parents or teachers. The controlling factor seems to be the advice or suggestions from people who have never attended college and particularly from persons connected with contracting or engineering firms. It appears that about half the high schools have tried to bring to the attention of students the advantage of a college education and that a few instructors in these high schools have attempted to analyze the native ability of the boys and to advise accordingly.

The reason as to why the engineering college has been chosen is largely because the young men, through work with engineers or contractors, have become interested in this occupation. Nearly two thirds of the engineering students have one or more relatives engaged in engineering. Only 12 per cent. indicated that the occupation of their father was engineering, while 95 per cent. of the freshman class had parents neither of whom had been to college. A large majority, or about 80 per cent., of the students assert that they have definite knowledge of the fact that the financial returns in the engineering profession are less than those in other professions.

If the above noted conditions are typical, it appears that in order to attract more young men and to arouse in the high-

school students an interest and appreciation of the value of engineering education, certain systematic work should be pursued more largely through engineers and contractors, calling to the attention of each of them his particular duty as a citizen to make known to the bright boys in his neighborhood the opportunities offered by the engineering colleges, also the advantages possessed by a young man who has made use of these opportunities. It appears that the American boy is guided more by examples and by advice of this kind than by anything his parents or teachers can or do say to him. It is the environment outside of school and home which appears to influence his choice of future occupation.

With reference to economy of time (paragraph 28) several educational institutions have already begun to seriously consider this. The most interesting case perhaps is that of the University of Missouri which in its new three-term calendar states:

"The war has made it necessary to increase efficiency in educational enterprises as well as in enterprises of other kinds. The necessity of conserving time and eliminating the waste of holiday and closed seasons has led the University of Missouri to adopt an all-year calendar, which, it is believed, will prove equally desirable as a peace-time program.

"Beginning with the next regular session, which will open for registration August 30, 1918, the school year of the university will be divided into three terms of sixteen weeks each, instead of two semesters, of approximately the same actual length, as heretofore. Under this plan the university's educational machinery will be in operation during the entire year, with the exception of two weeks in the latter part of August and a week at Christmas.

"These terms will be known as the fall, winter, spring and summer terms. Students may take only one term a year or all three, though it is believed that in most cases best results will be obtained by studying not more than two and one half terms consecutively."

An equally important but perhaps more difficult question is that brought up in paragraph 29 with reference to getting and keeping good instructors. The time has arrived when the full sunlight of publicity should be turned upon the profession of engineering education. A careful examination should be made not only into the present conditions, qualifications, activities, and pay of the instructors, but also into that of men who may be utilized as instructors, together with a comparison with similar conditions in private and public service. In this age of organization when in almost every line of human activity united efforts are essential to human progress, the engineering profession stands out prominently through its disorganized condition or rather multitude of unrelated societies and lack of unity on all important questions.

Individualism in ideals and methods has been carried to an extreme with the result that while engineers as such are performing great work for the country, yet as a body they are practically unknown and unrecognized in larger public affairs. In fact it may be said that taking the man on the street while he knows what is a doctor, a lawyer, or an architect and recognizes the authority with which their organizations speak, yet his definition of an "engineer" rarely gets beyond that of "a man who runs an engine," and his conception of an engineering organization is typified by that of the Brotherhood of Locomotive Engineers. He and his representative in the legislature or in Congress possibly never hear of an engineering society in the sense in which we here use the term.

Widely prevailing ignorance regarding engineering as a profession is due to the fact that we as engineers have made little effort to educate the public along these lines with the result that the public little knows and appreciates less what it owes to engineering, nor does it realize the vital importance to the community of getting and keeping effective engineering instructors. Failure in this respect is due to our own neglect.

We have a present duty to awaken or educate public opinion to a degree such that it will support the efforts to get and

keep good instructors, securing for them a fair compensation. As long as the condition exists, as it does today, that many of our instructors can go out and obtain larger wages at skilled trades or even in simple mechanical labor, it is of course almost impossible to pick and choose our men. The fact that they can do this is in part due to the indifference of engineering organizations. This has been fostered in part by a high sense of the ethics of the profession, looking down upon everything which savors of commercialism.

There are unfortunately no standards of salaries nor data by which these vital matters may be discussed. The American Society of Civil Engineers has made some investigations into the earnings of its members, but as yet there has not been a thorough, business-like or scientific analysis of what may be termed a fair wage or the relation of responsibilities or performance in engineering education to the compensation paid. The result is,—as in all cases of this kind where there is lack of information and of organization,—that the minimum wage is paid and there is strong temptation constantly offered for the more energetic men to accept tempting offers from outside.

On the other hand our instructors are required by custom to maintain a certain appearance of respectability. They share in the condition described by Gen. W. M. Black at last year's meeting as "nothing but genteel poverty from beginning to end." (PROC. S. P. E. E., Vol. XXV, p. 39.)

Again the question may be asked, "In view of these conditions are we as a society for promoting engineering education keeping up to the full degree of efficiency, one which we are supposed to demand from our students?" Are we not giving most of our time and thought to the minor, but more interesting details of our work, and putting to one side the vital problems of getting the necessary raw material, of finishing it off rapidly and effectively, and of getting and keeping the highest obtainable grade of instructors, "the men behind the gun" in our institutions?

A TECHNICALLY PREPARED RESERVE TEACHING CORPS.

BY W. J. RISLEY,

Professor of Mathematics, James Millikin University.

I know how to quit in four minutes in a theater, but whether I can do the same here I don't know.

We have talked about efficiency in engineering instruction and the instructor being prepared technically to do his business and that is my aim.

I have among my past students three or four who are holding army instructional positions, two of whom are teaching gunnery, about which I know nothing. I know which end of the gun is supposed to have the shell in it and I know out of which end the shell is supposed to go toward Berlin, and I imagine that is about the sum total of gunnery knowledge in this room.

I think if my students can go to Norfolk and take coast artillery and become sufficiently expert to teach it when they have no more mathematical and physical equipment than we give them, that perhaps I might and you might in two months learn enough without technical foundation, so that when the time comes and these boys of Pershing's age are needed in that drive which must come before we complete our business in this war, the three- or four- or five-million army which must go may be sent to Millikin and Illinois and other places, or that we may be drafted into service, taking the place of these boys who may be useful in the active military service. Hence, I believe three or five hundred, a thousand, or fewer or more of us, who may be disqualified for military service abroad, might well be placed in these various schools where we might be able to absorb enough of this information that when the time comes, we as technically educated and trained

reserves, might be called upon whenever, in the judgment of the department, we should be conscripted to take the places of these men who are called into active duty.

Some one says, "Suppose the war is over before you get it done." Then I will have accumulated something which I will be pleased to hand back to Uncle Sam with good compound interest. I will have gained something that will make me a better instructor in the time to come. It is not lost.

One of my former students is an instructor in machine gun work at the University of Illinois. My oldest boy is a student in the ground school there. I know that student was sent from Columbus, Ohio, barracks to Champaign for further orders. As soon as he arrived he was informed that he would be a machine gun instructor beginning three days later. He got his first book then on machine gun instruction. That is how much he knew about it. He had from Saturday to Monday morning to keep ahead of the youngsters.

I presented this matter of military instruction to Professor Mann and it has his hearty endorsement. I also have his instructions as to how to get it through when I want to write down to Washington. I present it to you for discussion and for such action as you may care to take.

Chas. S. Howe: Mr. President, I take it that the War Department is already considering matters of this kind. Eleven engineering institutions have been asked to nominate one professor each to go to Fort Monroe this summer to take a two months' course in gunnery. The greater part of the work is to be theoretical and the men are not to be in uniform. Some of the work will be practical work with the guns. We have just nominated our man to go there. I take it this is an opening step.

They say in their circular that it is important that gunnery be taught in the engineering institutions and that they are trying to see whether they cannot find members of the faculties to be taught enough gunnery to give courses to the students and interest them in the coast artillery, which depart-

ment of the Army has been making a very great effort to get our engineering graduates. I believe that before very long the War Department will extend this matter and will invite all of the engineering colleges to send members of their faculties to such schools.

C. Russ Richards: Apparently this Committee on Education is endeavoring to stop the competition of the different branches of the Army for technical men. Such action is a step towards the coördination of the needs of the Army and the apportionment of technical men to cover as nearly as possible such needs.

Of course, this is propaganda on the part of the coast artillery. They want instruction given to interest the best of the men in its branch of service.

President Howe: I take it that the institutions are going to send men down to Fort Monroe.

Dean Richards: We are going to.

T. U. Taylor: Mr. Chairman, we have had some experience with this method of recruiting raw instructors.

About seventy-five of my own ex-students are instructing in these ground schools or in similar schools, but the method does not consist of such procedure as the gentleman described who would lead us to believe that a student got there one morning and was going to instruct the next morning. These men are carefully selected after considerable investigation. They are brought there as instructors, but they do not go into the actual work for some weeks. They are put in classes first, and the government has been very careful in selecting them; they are not the raw products, but they have the foundation. They are already at least junior engineers and most of them are graduates. It is their technical training which is the foundation.

I was filled with fervor to get into one of these schools, but I was told they didn't want any men over thirty-five, so my patriotism had to have an outlet in making four-minute speeches.

W. T. Magruder: Mr. Chairman, the practice is to put these men in the classroom as students and as observers for two weeks, and also in the laboratories. They are graduates of schools, have practical experience, are twenty-five to thirty years of age, are engineering graduates with several years' experience in motor car work. I think the case Professor Risley mentions must have been an exception.

Professor Risley: I have no intention of diverting the discussion. The point I want to make is whether or not we think it is a good idea for us to be put in some technical place as President Howe has said. What do you think of the proposition that we should offer ourselves to be placed in these positions where we may be technically trained? I have just used guns as an instance.

Professor Magruder: I might add another statement. We have a man at our aviation school who is an expert in gunnery, but being a civilian, he is to be replaced by order from Washington by a young instructor in gunnery. There is a difference between his being an old experienced man in the art of gunnery for many, many years and not wearing a uniform and the man who does wear a uniform.

Professor Risley: Then you mean the government will hold to Army men?

Professor Magruder: Yes.

Professor Risley: I should hold, then, Mr. Chairman, that the idea should still prevail. I am perfectly willing to be called an Army man. I am perfectly willing to have them take me. They can take my youngsters and my cash and they can take me. I think we should be prepared to do the job. I am willing to be an Army man and wear a uniform and do all that the uniform calls for.

REPORT OF THE JOINT COMMITTEE ON ENGINEERING EDUCATION.

BY C. R. MANN.

Mr. Chairman and Gentlemen: Four years ago at the Princeton meeting I first appeared before this Society and discussed the possibilities of a report on engineering education. It is appropriate that the final report on the subject should be presented here at Evanston, because, when appointed to undertake this study, I was at the University of Chicago, and the problem was entirely new to me and outside of my then work. I there made tracks as fast as I could to the nearest source of enlightenment upon this subject—Director Hayford, of Northwestern—and the first formulation of the outlines of this study were made in two long sessions in the director's office upstairs. Along the general lines there discussed, the work has proceeded for the past four years.

I was very much interested last evening to hear Director Hayford's statement of the ideals of this school of engineering. There were two things in his remarks with which I wish to take immediate exception. He stated that the ideal of the engineering college here is the thorough training of the engineer both in science and on the humanistic side so he should be an all around man, capable of carrying on his profession successfully, not only in the two or three years after his graduation, but for the next forty years of his life.

That is an ideal with which we all agree. He stated, however, that the policy of this school was to keep the men here for five years while the policy of the country has turned to an intensive training which is much shorter; and, therefore, he said the ideals of this college had to be held in abeyance for the next few years, but he hoped to revise them after the war. Those last two points are the points on which I do not share

Director Hayford's view. I do not share the view he takes that these ideals are in abeyance in the slightest degree during the war, nor do I agree that it takes five years to develop a man of the type that we all want to see developed. In fact, this crisis in which we now find ourselves is the time when the engineering profession should show the schools how to develop themselves so that they can accomplish the desired result in a very much less time than has usually been supposed to be required. It is perfectly obvious to any one who is familiar with college education that we have never put an adequate amount of steam into our college studies.

The reorganization of education so that the students have more steam,—so that they go to work with the same spirit that they go to football games,—is essentially an engineering problem; and I believe that this association at this time can safely follow the advice given by Mr. Baker last night, and undertake to develop a new type of engineering education which will accomplish the ideals which Mr. Hayford mentioned last night. It is an engineering problem.

You remember Watt's first engine was a ten-horsepower engine. He set it up in a factory at Manchester to test it. A large crowd assembled and Watt himself wrote of the occasion: "The crowd was enormously impressed with the magnitude of the engine and with the awful noise it made." Now that engine consumed ten pounds of coal per horsepower hour. Ten horsepower,—enormous wheels going around with great ostentation and awful noise accompanied the display of the engine. At present in the power plants we see a large round cylinder and hear a gentle hum, and there is five—seven—eight thousand horsepower being developed at one pound of coal per horsepower hour. The conversion from the one to the other has been an engineering problem.

We have an analogous condition in the schools. We are ostentatious, the wheels are going around, there is a great deal of noise; yet too much energy is escaping through the safety valve in shouts and steam on the football field.

The report is now finished. The proof was sent to the committee about the middle of April. There are one hundred and twenty-five pages. After the Joint Committee on Engineering Education had this for about five weeks, they held a meeting in New York on May 24, at which they voted to approve the report as it was with a few minor changes. Those minor changes were incorporated and the document is now ready to be printed. It was, however, felt very desirable to preface the report with a suitable introduction by the committee, stating the history of the movement and giving an explanation of the particular ideas or particular lines of activity which the committee feels the report is well calculated to stimulate. That introduction has been written and is being circulated among the members of the committee. When it is finally approved, a brief introductory note will be written. As soon as these introductions are in proper shape the report will be issued.

It has been arranged that the members of this Society will all receive copies as soon as it is off the press. I am sorry to say it will take some weeks, certainly not later than the first of September, before it will finally be in your hands in finished form.

It has taken so long to prepare this report—four years since I began work—for several reasons. The chief reason is that during these four years the engineering profession has radically changed its own views as to what engineers are for and what their particular problem is. Of course, it was useless to issue a report that would merely describe the situation as it was then and would not point out any direct road of progress that would be useful for the next ten or fifteen years.

In the second place, the report as first written was too long. It would have filled some two hundred and fifty pages of print. Dr. Pritchett felt it was much better to shorten it and make it more direct. Therefore it was rewritten as reported last summer at the meeting in Washington. Since then it has been completely rewritten again and has finally been reduced

to one hundred and twenty-five pages, which any one can read in an afternoon and then digest at his leisure.

The report is divided into three parts,—like "All Gaul." The first portion deals with present conditions. It treats of the development of the engineering schools in the United States, their early history and the aims and curricula of the early schools. It shows how Rensselaer, for instance, built up its first curriculum, where it got its money, how the Massachusetts Institute of Technology curriculum was established. It points out the close resemblance between the early curriculum of Massachusetts Institute of Technology and that at Rensselaer, and calls attention to the fact that the Rensselaer curriculum was imported from France. It deals with the struggles for recognition and the obstacles the engineering schools had to overcome because of the failure of the professional engineer to recognize that engineers could be trained in school. Up to that time engineers had been merely trained by the apprenticeship method.

It deals with the changes of curricula from the beginning to the present time and discusses their content and the distribution of time among the various courses. It discusses the methods of administration in engineering schools, faculty control, student elimination and progress. Much of this material has already been presented to this Society as to the percentage of students that are eliminated and the percentage of low grades in various subjects. It then takes up types of instruction in engineering schools, and indicates briefly some of the common practices in teaching the standard or fundamental subjects such as physics, mathematics, chemistry and English. That first part is an attempt to state what present practices and conditions are, and to describe the situation that needs analysis.

The second part tries to analyze this situation into separate distinct problems. It is called "The Problems of Engineering Education." The first chapter deals with the problem of admission,—what the present practices are, how the present

practices have developed, what questions are being considered now by the schools in reference to their entrance systems, what experiments are being made,—and it attempts to demonstrate that the development of entrance requirements in the past fifteen years has been away from the control of individual judgment in deciding whether a boy is fit for college or not and toward a system of committee control. The College Entrance Examination Board, as you know, was organized to do away with this individualism in college entrance examinations,—where the professor gave his own examinations and made his own decisions as to whether the boy was fit to go to college or not. This was a step away from reliance upon the personal judgment and bias of individuals and toward entrance tests upon which all individuals will agree; that is, objective tests. In order to indicate how such tests could be developed, and what reliance could be placed on them, a series of experiments were made for the Carnegie Foundation by Professor Thorndike of Columbia University. These experiments are described in the appendix.

The second problem is called "The Time Schedule." Attention is here directed to the fact that the current practice in making curricula is for the faculty to discuss only how much time shall be allotted to each particular subject. As you all know, the Committee on Curricula, or something of that sort, meets, draws up a schedule and says, "We will give five hours a week Freshman year to mathematics, five hours in chemistry, three hours in English, etc.," and having determined the time schedule, they turn this allotment of time over to the department and in general allow each department to do whatever it likes with its time.

So far, little effort has been made to reverse that process and determine what information and ability in mathematics an engineer must have and how much time it takes to train the average of the class to that degree of skill in mathematics; and then to allot that time to the mathematics department. Little progress has yet been made in experimenting,—for a

lot of experimenting is necessary to find out the answer to the question: "What mathematics must every engineer have thoroughly mastered and how much time does it take to teach that to a reasonably intelligent youth?"

The content of courses is the next main problem—"What shall we include in the different courses?" This needs no further explanation.

Testing and grading is the next problem. It is here pointed out that current methods of testing and grading in college are like entrance examinations still subject to the fallacies of individual judgment because every department certainly, if not every individual professor, sets its own examination papers and passes its own judgments. Under those conditions a test is apt to measure more how much a student has conformed to certain points of view of the department rather than to measure his real ability in handling the particular subject. So the question is raised: "How shall we conduct testing and grading so as to make it a real test of the student's ability to handle the material they are supposed to handle because of their participation in that course?"

It is pointed out that a real test of ability, which is objective in the sense that everybody must agree to the finding of the test, is an enormous incentive to a student. It releases his energy to achieve the best that is in him. Such a test is everywhere used in athletic work, because if a man runs the hundred yard dash in ten seconds or eleven seconds, whatever it is, everybody can measure the time and determine accurately and objectively whether he has achieved what he should achieve or not.

At present there is very little such testing in college work. If we can devise tests that are real measures of achievement so that the boy feels when he has received "A" or "B," that this measures his real ability, you have in your hands a weapon of enormous power for releasing the boy's energy and aspiration to achievement.

The next main problem is the shop-work. This is analyzed

in this way: There are a number of types of shop-work. One general type merely sends the boy out to observe what is going on in shops. That was the original type at Rensselaer back in 1824. It is still carried on in a very effective manner at Yale. There they have ten days in the junior year when the class comes together and is taken through certain shops and shown certain particular operations in practice; then they go back and discuss these and are told about what they are going to see the next day. The next day they see other shops, observe other practices, discuss them and write reports. This practice has a large value. It is very much like the shop excursions to visit industrial plants.

The shop-work that is given at Worcester is of another kind which began with the founding of the Washburn shops back in 1868. The idea here is that it is essential that shop-work have a direct commercial value,—that the boys build something salable, and that the test of the shop-work is its salability in the open market. This is an objective test. The shop-work is still conducted on this basis at Worcester. The boys are given certain exercises to develop skill, and then produce drill-presses and other machines which are sold in the open market. I believe Rose Polytechnic Institute runs its shop on the same basis.

The idea of connecting production with the shop-work and making the production methods an essential part of shop-work has received different treatment at the University of Illinois, where they call the shop a shop laboratory. They manufacture a two-cylinder gas engine in a shop that is organized as if it were a real producing plant. It has its planning department, its specifications for every job and its tool room. The boys take turns in passing from one division to another and thus get experience in all operations of the shop. It is run on a scientific management basis, and incidentally the students get some skill with machinery and tool work by carrying out exercises that are specified in the same detail as would be the case in a regular plant. The idea is to make the

shop a laboratory in which to demonstrate to the student how to run a production plant scientifically. The students work with great enthusiasm and there is a real objective test there because the different squads of students are rival teams. They have to get their jobs done in a specified time and they rival one another as on the football field. There is real snap in it.

The other type of shop-work, which is the common one in most of the schools, was started by the Massachusetts Institute of Technology in 1876. President Runkle went to the Centennial Exposition and saw samples of the Russian system of shop-work, in which production was entirely divorced from construction. Production processes were analyzed in the fundamental shop operations of filing, chipping, boring, etc., and each boy was made skilful in each of these operations. Having learned these physical manipulations, he was supposed to get his construction experience after he graduated. That is the type of shop-work that is now found in most of the engineering schools.

There is one other type of shop-work and that is the type at Cincinnati, where the boys spend half of their time in a real shop, doing real production work for real pay, and the other half in school, discussing the problems which they have discovered in the shop. This Cincinnati plan, I find, is usually conceded to be a plan to get familiarity and experience with industrial shop-work and the general prevailing opinion seems to be that it is a very good plan for producing mechanics—high-grade mechanics—but it is not the scheme to be used for developing the type of engineer we all want to see developed.

It is perfectly obvious, of course, that no school has yet achieved the ideal, but the underlying notion in the Cincinnati plan is that real production work,—industrial practice,—is the source of all engineering problems; and, therefore, a man is best trained to solve engineering problems by practice in solving such problems. Hence the student should be taught in the shop to find problems and to bring them out of industry back to the school to be solved theoretically there. This

idea has been developed still further at Cincinnati until at present certain of the students in the junior and senior years no longer work in industrial plants at industrial jobs but work in the research laboratories of those plants.

The process of selection on the basis of—"Can the boy see the problem in the physical situation; can he take that problem back and solve it?" is one that picks out the men who have the research ability. At present a number of the Cincinnati students are working in the Dayton laboratories as research assistants in electrical lines and these are found to make extraordinarily satisfactory research men; so that if the general principle of seeing the problem in industry and carrying it back to the college for solution is emphasized and stuck to without being carried away by the mere manipulation, the Cincinnati plan does enable us to develop and select men of research ability in a novel but thoroughly satisfactory way.

Therefore, the question is raised as to whether this plan of shop-work, where the students spend part of their time in a real industrial plant, there meeting the real problems of industry and thence carrying them back to the school for discussion, does not offer a clew to a fruitful solution of the shop-work problem.

The Massachusetts Institute of Technology has developed in the past year some similar work in the chemical and electrical engineering lines, and a very interesting experiment is now being developed in connection with the Western Electric Company by Professor Wickenden. I hope that Professor Wickenden is here today and that he will tell you what he is planning to do in connection with developing boys at the Western Electric Company and the Massachusetts Institute of Technology along this line.

Please notice I am not passing judgment on the answers to any of these questions. The report doesn't do that at all. It leaves you to decide whether you will try anything different

from what you are now doing or whether you will continue in your present practice.

The third part of the report suggests solutions of the problems that have been discussed. It is hard for me to explain these suggested solutions because they are so extensive.

The first chapter deals with the problem of how to construct the curriculum. The report advocates the principle of trying first to determine what abilities an engineer must have in fundamental subjects; that is, what the engineer must be able to do with mathematics, what he must be able to do with his physics, with his chemistry, etc. We must first determine what is the information and what are the abilities that every engineer must have—every engineer! I believe personally it is possible to determine this to a high degree of probability. Having determined this and having made a list of all the things that an engineer must know and must be able to do in mathematics, in chemistry, in physics, in shop-work and in laboratory work, I believe that it is possible to find out on the basis of experience he has already had and with a little experiment, how much time it is going to take to teach an average boy these things and to make him skilful in these things.

Therefore, I suggest that the curriculum consist in the first two years or the first three years (I will leave the time undetermined) of simply the things that every engineer must master. We will have to find out by experiment how long it is going to take to teach these things, for it may take a year and a half, or two, or three years; but there certainly is a common body of information and certain common abilities that are fundamental to all branches of the engineering profession and every boy should get them and get them first.

This information and these abilities cannot be developed, it seems to me, by mere instruction of the type that is now given. That is, if you merely instruct the boy in his mathematics as you now give it for five hours a week and don't make him feel that mathematics is an essential part of surveying and me-

chanical engineering and everything else the engineer does, his mathematical training is not likely to be so transferable and usable in engineering practice as it is if he feels while he is doing his mathematics that it is a real thing.

In order to accomplish this end there are three phases of engineering work which should be closely correlated and developed together. One is the industrial phase. The student must know something about the problems of engineering as they actually occur in industry and in the world's work. Mind you, I don't say it must be the Cincinnati type of experience; it may be work in industrial plants, it may be the Massachusetts Institute type or some other type, but there must be some school-supervised contact with real engineering work under real conditions. There must also be running parallel with this a certain amount of engineering laboratory work in the school where the young engineer learns to answer the questions that can't be answered in any other way. He finds the problems in industry and brings them back for solution to the school. Some of these problems can be answered by theoretical work only, but others can be answered only by experiments in the laboratory.

The third essential factor in the backbone of the course is the theoretical work in mathematics and science.

Those three elements seem to be essential to the entire course all the way through. We should not set the freshman in to studying only mathematics and theoretical chemistry with abstract scientific laboratory work, modern languages and English. We should not wait until the middle of the second year before giving any of the real engineering experience that seems so essential to close the safety valve and not allow so much energy to escape on the athletic field. In order to get more skill in the engineering work it is necessary that we have in the very beginning of the freshman year engineering laboratory work in parallel with the theoretical, mathematical, physical science work, in order to make the school real to the boy and give him a real enthusiasm for it.

But when you have done this, you still have not answered the question of how you are going to develop the man as a man and what you are going to do for the humanistic side of the engineer.

This question adds a fourth element which seems essential for every engineer through his entire course. This requires a definite course which is planned simply to develop in connection with the engineering work an appreciation of the human relation involved in engineering and the humanistic values he must understand if he is going to be a real man. There are a great many ways in which this can be done, but the type of work which seems most worth trying is the type of work now being done at the Massachusetts Institute by Professor Aydelotte in his English literature designed to give the engineering student what he really wants to know about English litterature. Professor Aydelotte begins by asking the boys why they came to college, why they want to be engineers, what an engineer really is, why an engineer is different from a mechanic, if there is any relation between the engineer and the writer of English literature, etc. He discusses those things and gets the students to write themes that are often remarkable. Incidentally the boy also learns to express himself clearly, to write good English and to like good English literature.

This same method can be applied to the study of sociology, the study of economics, and so on, and therefore, the report suggests that we carry along throughout the entire course, occupying possibly a quarter of the man's time, a course of this sort which gives the student some acquaintance with and appreciation of the best things in English literature, philosophy, economics, and human relations generally. This suggestion completes the first part of the curriculum—the part that is common to all branches of engineering, and imparts the information and abilities that every engineer must have.

Throughout the entire course a great deal of attention must be paid to the testing and sorting of the men. Testing and

sorting processes were in a very vague state a year or two ago. But an enormous amount of experience is being developed and collected at the present time by the efforts of the War Department to test and sort men for the Army mobilization. The Department now has psychological laboratories for testing all the men in two of the camps. They have personnel officers in all of the camps, and the work is making rapid progress. An enormous amount of information as to the meaning of these tests and their validity in sorting out ability is being gathered and digested and trade tests are being devised to pick out specific ability for certain lines. Before the war is over we will doubtless have some very reliable information as to valid methods of using objective tests and this will be of enormous importance in selecting students for admission to engineering schools and in sorting young men during the first year or two of their course, so as to decide whether a boy ought to go into the civil engineering or some subhead under civil engineering, or into mechanical or electrical engineering. In other words the experiences with the students in their common work that extends over two or three years should be utilized not only to train the man's ability to know and do things, but also as a means of vocational guide to select men and steer them, in the latter part of their course, into the special lines of work for which they are fitted. So the latter part of the course will be made up of large groups of specialties. Those who have been selected by the first two or three years' work as qualified for civil engineering will be put in a group where for the next year or so they will deal first with all the materials of civil engineering not included in the first two years, but which are essential to all the sub-specialties of civil engineering. Then they will proceed from that into some particular specialty.

The next chapter deals with the teachers, and the essential point there is that the teacher is, of course, the crux of the situation; and that the present organization of universities is not well qualified to encourage teachers to experiment and

undertake the sort of investigation that is going to be necessary in order to put a plan of this sort into operation. Hence an organization at the school should be made for the purpose of studying the teaching problem, and the school and faculty should recognize at the start that it is some business of the professor of physics what the professor of mathematics is doing; and it is some business of the professor of electrical engineering what the professor of chemistry is doing. We must drop the practice of simply deciding at the faculty meeting how much time these different subjects shall have and take up the practice of discussing what the work of each department shall be.

Hughes Committee

When this has become recognized practice, the mathematics teacher, if he goes into it in the right spirit, instead of feeling that his interests have been sorely trampled upon when the professor of physics or engineering presumes to tell him what they want done, will find his work in mathematics has become enormously more inspiring to him and to the students. It will engender good feeling of the very best sort and result in a release of creative energy among the whole faculty. This is a cardinal point—that conditions be developed at the schools that will make the teachers want to study their problems together, instead of the present conditions which discourage the undertaking of anything that is not according to Hoyle. Those of us who had the temerity to break away and study education in spite of the present system took our lives in our hands. But yet we have lived till there is prospect we may still see that system develop.

I may say the position which I nominally hold of Professor of Education at Massachusetts Institute is created for the purpose of developing this kind of a study of the teaching problem at the Institute. The work has not yet started because of other more pressing needs, but there is a recognition and a willingness to do this work at the Massachusetts Institute, and it has got to be done in order to develop the teacher and to release his inventive ability and his creative energy so

that he can really put his enthusiasm into the problem on which he is working.

The last chapter deals with the professional engineer and its contents has already been presented at numerous meetings. In the opinion of the engineering profession itself, the most important things for the engineer are character and good judgment and efficiency to do things and to understand men. These are first, and then comes his technical knowledge and his technique. Hence the ultimate question is—how are you going to train people so as to develop these personal qualifications while you are giving them the requisite technique and skill and knowledge?

Of course, we all know the function of the school is to turn out men who know things and can do things; and if we can give the other qualifications in addition, well and good; if not, the function of the school is still merely to make men who know and can do.

In this connection it would be well to read two of Hobson's books. One is called "Work and Wealth," and the other is called "Democracy after the War." They are published by The Macmillan Company. The second book has been out only a few months. These books suggest the fundamental conception which seems to lie back of this whole problem; namely, that the underlying question in any undertaking, and the basis upon which an individual makes up his mind as to whether he will do this or that or something else, is the question whether the thing is really worth doing from his point of view. He says to himself, "Is it worth while that I do this rather than that? Is the game worth the candle?" It is on that fundamental issue that the real decision is ultimately made.

The successful men are the men whose conceptions of what is worth while agrees most accurately with the underlying conception of the masses of humanity and who therefore make that judgment most accurately and most correctly. Hence in order to train the engineer to pass judgment on the ques-

tion—is it worth while?—in a manner that shall be accurate, definite, and as it were inspired, we must train him to appreciate profoundly what humanity considers really worth while. This means, of course, that he has to be well versed in the humanistic side of life, so that the problem resolves itself into the question—"How shall we teach the engineer to understand and appreciate and fight for the things that humanity considers to be most worth while?" It is, you see, the same old problem of education that colleges and universities have been trying for years to solve.

The report suggests that much can be done to this great end by introducing into all of the engineering work and all of the humanistic work a consideration of the question of values and costs. Decision is always reached by weighing,—I am to get this value for this cost; is it worth while? So if we include the appraisement of values and costs, we must not limit the discussion to monetary values and costs. Every engineer knows perfectly well that the decision as to whether to build a bridge or not is based ultimately on the answer to the question—"Is the value of the bridge to the community worth the cost?" A long series of more subtle appraisement of human values must precede the engineer's calculations. It is the power to solve these subtle problems which causes the man who is skillful to make progress and become the great engineer. A great engineer is the man who is subtly powerful in judging the balance of values and costs in the most far-sighted way.

Therefore in order to develop men who can appraise values and costs and make a sound decision, practice in this should be included in all the engineering work. This means that when the student is working at mechanical laboratory work he will be given as a problem to determine whether certain gears should be made out of steel or phosphor-bronze to fill certain conditions and in consideration of the price of the goods and the difficulties of manufacture, etc.

If questions like these are intelligently introduced into all

of the engineering and the scientific work, it will do much to answer eventually the engineers' demand that we develop men of character, judgment and so on, along with technical knowledge and skill.

This is the gist of the report as it stands. I regret that it was not possible to issue it to the members of this Society prior to the meeting so you might have had time to look into the details and digest it and thus take part in a real red-hot discussion. I know the engineering schools are going to divide into two camps on this subject, those that are for it and those that are against it. You can't occupy middle ground. You either come all the way across or you stay all the way on the other side.

It is like the present situation in the world's crisis; you can't take the middle ground. As the darky put it in his sermon one morning—"Brethren, the whole world are at war. Nations are scrappin' with one another, and this ain't no time for a nigger to sit on the fence. In the old days when I was a boy they used to make the fences out of rails, and a rail fence was a pretty good thing for a nigger to sit on, but now they make the fences out of barbed wire and this ain't no time for a nigger to sit on the fence."

WOMEN EMPLOYES—PLANO WORKS.

BY F. J. GERNANDT,

Superintendent Plano Plant, International Harvester Corporation.

To us at the Plano Works, West Pullman, it has been an interesting experience. About a year ago we started to put girls to work in our factory. The first job we put them on was to inspect parts for roller bearings. We previously had young men doing this work, sitting at a bench and measuring with micrometers. We needed the men for machine work and thought it was a good time and place to try out girls. We made it known among our men that we wanted a few girls; and if they had daughters, sisters or friends, we would be glad to take their applications. From that time on we have had no trouble getting female help. It will be of interest to you to know that to-day we have a waiting list of 250, all living in this district.

At first, the men were not accustomed to female labor, but in a short time the shop adapted itself to feminine help, and now they seem to treat it as a matter of course. Up to the present girls have not been placed on so-called dangerous tasks, where there is a chance of bodily injury; neither have they been placed where they would be subject to severe heat or cold. We have tried in every case to pick the woman for the job she is to do; and when interviewing applicants who are asking for work, we try, as far as possible, to class them according to age, past experience, type, nationality, health, physique, intelligence, cleanliness, education and general aptitude.

As we never employed women before in the factory and started slowly, it has given us a good opportunity to reëstablish the personal touch between the employes and the office, which so often gets away from us in a large works. I make

it my business to go through every department where girls are employed and examine their work, taking a personal interest in their working conditions and earnings; and do not hesitate to show them in every way that we think just as much of them as we do of the men.

On the whole, it is our observation that women are more attentive, show more interest in their work, and are anxious to make good on any job you give them.

A rest room and lounge room has been provided, furnished with chairs, reading table, lounges and magazines of various natures. The girls stop work ten minutes before the men, which prevents the mingling which is often objectionable to the women going out through the halls and stairways during the rush after the whistle blows. It also gives them an opportunity to get on the street cars before they are crowded; although, as I have mentioned, we try to hire mostly from this immediate locality.

It is true that women require more supervision, and the overhead, such as rest rooms, matron, etc., is greater for them than for men, but we feel that it does not overbalance the scale. The matron acts as a bumper between the foreman and subforeman and the women. We do not ask her to exercise any authority whatever in regard to the girls' work. To make myself clear: If a girl does not work as steady as she should, comes in late, or spends too much time in the rest room, we expect the foreman and sub-foreman of the department to discipline the girl. The matron is primarily on the job to look after the girls' welfare. Of course, if the matron thinks the girls are not doing the proper thing, she would call the attention of the foreman and sub-foreman to such cases, but we do not expect her to enforce discipline of any kind. Her function is to get and keep the good will of all the girls and women in the factory; so they will always have someone to go to with their problems, whether they are matters occurring in the factory or in their private life. Our matron tells me that a man can swear, but a woman must have a cry to placate her.

In the inspection department they work out well on a class of work where gauges and limits are already determined, and where it is not a case of judgment.

Of the first lot of nine girls that went to work in the inspection department, all are with us at present, with the exception of one, and she left to get married. With few exceptions, they have lost hardly any time this year; and last winter during the severe weather they came to work when many of the men did not. We put the girls into the same room with the men, but at one end. We have no fault to find with the quality or quantity of work they do; and after serving long enough to become proficient, we rate them the same as the previous workers on that particular class of work. Within their limits, which are mainly physically, they can do as much work as previously performed by men. A great many of the jobs performed were formerly done by young men or boys, who grew up with the job or machine and were really in a blind alley. The girls readily learned the use of micrometers and fluid gauges used in this type of work; and it was not long until we had replaced all the men with the exception of a floor inspector, whose duties include the supervision of the women inspectors. The girls are anxious to make good on any work you give them. After a few months of bench work and giving them a chance to become shop-wise, we tried them out on small grinding machines. This was done by boys, and being a steady grind it was hard to hold them down. These machines were in the room and close to where we had the girls on inspection work. The boys were taken off these machines one at a time and girls put in their places. On jobs of this nature they worked out to good advantage. The girls have taken to this work nicely. We have comfortable stools and favorable working conditions, and they earn more than the boys did, simply by sticking to the job. The floor inspector oversees the work and the sub-foreman adjusts and sets up the machines. This was also done for the boys.

The girls, at first, were reluctant to try machine work, but

when they found out by experience that they could earn more on a machine than on a bench, we had no trouble to induce them to try machine work. The work is all light and adapts itself nicely to female labor.

We also have girls on packing and counting, running drill presses and a girl timekeeper. While this is not new regarding the employment of women, yet, to us, it is a case of where men did every job previously; and I might say, this same applies to all the other departments.

In the department where we make magnetos there is a great variety of bench and machine work. The girls in this department become very apt and as there are a large variety of pieces and operations, the work is of such a nature that we can change them about often, and place them on such jobs that they are naturally fitted for. In this department, we have girls running lathes, milling machines, punch presses, grinders and drill presses.

In the tractor department there are girls employed at present assembling small parts, packing tool boxes, using soldering irons, riveting, inspecting radiators, etc. These girls can use a hammer about as well as a man, and were put on these jobs with special attention to their strength, although we make it a practice never to require a girl to lift more than twenty-five pounds at one time.

In the paint department girls are doing brush work, stenciling, pasting labels, striping, and in fact, they are doing the work of a man wherever their strength will permit.

In the machine shop, on account of the weight of the material handled, we are placing girls on drill presses only, at this time.

In our chain department, where we make a heavy steel chain for the tractors, we are employing women altogether, with the exception of the trucking and heavy lifting. This is due to the fact that this equipment is all practically automatic, or semi-automatic, and being a late development at this plant, was designed with the idea in view that it would be

strictly a department for girls and women, including the janitor work. I might take this occasion to say that on all machines it has been our practice for years to make them as safe as possible and practically fool-proof, and we have had no accidents whatever from girls running a machine. In one instance a girl tried to show another girl how to pick a piece out of a machine and deliberately stuck her finger into a cutter and got a rather severe cut; but in this case the girl was not operating the machine, nor did she have any business showing the other girl what to do or what not to do.

Through the various departments we have girls inspecting. They inspect the various parts before they are assembled, and after they are assembled. In the machine shop they inspect such castings that are not assembled into any particular unit in the department, but go directly to the paint and packing departments. Such castings must all be thoroughly inspected, as there is no opportunity to catch mistakes after they leave the department. The girls and women look these over carefully, trying the gauges if there are any little defects which can be remedied by a little filing or fitting—they take care of these small jobs.

We had quite a number of men as timekeepers and office help, and as they are now leaving we are replacing them by girls. We find no difficulty whatever with the girls acting as timekeepers out in the departments where there is mixed help.

One thing which we are trying to do, is to standardize all clothing for the women in the factory. Overalls, or overettes, are being introduced, and some of the girls are wearing them. We believe that if all the girls are dressed alike, that there will be less rivalry as to dress, and probably less comments as to the matter of dressing. This is the information that the matron gives us.

We have not posted a single rule or regulation pertaining to girls or women which is not already incorporated in our regular factory rules; and about the only hard and fast un-

written rule which we have is: that there be no gossiping or quarreling. I am glad to say that if there has been a case of this nature, the matron has been able to take care of it without bringing it to the front office.

At the present time, especially in our departments where we employ skilled tradesmen, the younger men, where they have been placed in an exempt class of the draft, are leaving us to work in munition factories. As we are unable to get men to fill these positions, we are taking men who are exempt from the draft for various reasons, from the other departments, and placing them on machines and on jobs in the tool room, and training them to become proficient on this particular machine or job by appointing one of the tool room foremen as an instructor; and making it his duty to go from man to man all of the time, simply to teach these men to become proficient operators.

For instance: If we have a man in the machine shop who has been particularly apt on a simple class of lathe work, we take him into the tool room, put him on a lathe and train him to do tool room lathe work. If he turns out to be a good choice we keep him there, and he can eventually earn as much as a skilled lathe operator on tool room work. If, for any reason, he does not turn out suitable for this class of work, we train him in various operations on the lathe, so that we can turn him over to one of the manufacturing departments in which they have difficulty in picking up men accustomed to lathe work, and where the foreman cannot spare the time to instruct the men in the fundamentals.

This is the idea in general which we are carrying out, and we do not leave a machine idle nor a job wait because we are losing skilled men. We have adopted this method as the most practical way of taking care of our own present local conditions.

Eventually, it is my opinion that we will, perhaps, have to set apart a certain section of the shop, put in machinery, and under competent instructors run through various parts

of our machine production; and train men and women in this way to keep our work shops full of machine operators and semi-skilled workers; taking such as show exceptional skill and giving them opportunities to develop into skilled operators. This seems to be the only solution under the present difficulties.

DISCUSSION OF THE REPORT OF THE COMMITTEE ON ELECTRICAL ENGINEERING.

August 28, 1918.

TO THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.

In the July issue of *Electrcial World,* we the undersigned read the articles on "The Special Preparation of Electrical Engineering Students for Military Service" as given by the Committee on Electrical Engineering at the recent meeting of the Society for the Promotion of Engineering Education at Evanston, Ill. This, to our minds, was very interesting and in a way strikes a note of humor, as we are both graduate electrical engineers from two well-known institutions.

Private —— is a graduate of —— and has been in the service of his country four months. Private ——, a graduate of ——, has served nine months. Both of us were assigned to the Ordnance Corps and during our assignments never at any time have had opportunity to apply our engineering training. Recently we were assigned to the Chemical Warfare Service, U. S. A., and stationed at ——. Here too we thought that we would have an opportunity to apply ourselves but we have been placed in the boiler room of power plant No. — serving as coal passers. The men over us are all men of little or no education and even though the work is degrading we can not help but see some humor in it.

The crying need all over the world, both in civilian and army circles, is for technically trained men. The Engineering Corps alone could absorb every engineer now in the service. Schools and colleges are doing their best to establish war courses for engineering students but why are they not used once they enter the service? Applications for transfers to Engineering Units will not be accepted and still the men continue to waste their time and training.

Private —— has completed his course at the Westinghouse Electric Company and was employed until four months ago by the New York and Queens E. L. and P. Co. Private —— has been connected with Henry L. Doherty and Company of New York.

We do not cite our cases as a concrete example of how engineers are not put where they could be of best service, but we can mention more cases we have come across in the service; especially while throwing our time away in southern camps. The committee may see theoretically an advantage in establishing these military courses, but should they trace the graduates after entering the service they will find that results are different.

Now in closing we wish to state that this is a personal letter from two soldiers to a committee which is given national recognition and should our names be divulged it may lead to our court-martial, but even at that we could stand it. Nothing could be worse than a coal passer's place in a boiler room, but we hope that our names will not be given away.

Trusting that this letter will be of some little value to you and to other committees, we remain,

Respectfully yours,

PRIVATE .....

PRIVATE .....

COMMITTEE ON THE STANDARDIZATION OF TECHNICAL NOMENCLATURE.

SYMBOLS APPROVED BY THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.

June 28, 1918.

Concept.	*Symbol.*
Acceleration, angular	α (Alpha)
Acceleration due to gravity	g
Acceleration, linear	a
Area	A
Breadth	b
Center of rotation	O
Coefficient of friction	f
Coefficients and constants	C, K
Deflection of beam	y
Depth	d
Diameter	D
Distance passed over	s
Distance of extreme fiber from neutral axis	c
Eccentricity of application of load	e
Efficiency (hydraulic, mechanical, volumetric)	e_h, e_m, e_v
Force	F
Force, moment of	M
Friction, coefficient of	f
Head	H
Height	h
Horsepower	$hp.$
Hydraulic radius	R_h
Inertia, polar moment of	J
Inertia, rectangular moment of	I
Length	L
Load, eccentricity of application of	e
Mass	m
Modulus of section	Z
Modulus of elasticity, Young's	E
Moment of force	M
Moment of inertia, polar	J
Moment of inertia, rectangular	I
Quantity of liquid flowing	Q
Radius	r
Radius of gyration	k
Reactions	R
Revolutions per unit of time	N
Stress, unit	S
Time	t
Torque	T
Velocity, angular	ω (Omega)
Velocity, linear	v
Volume	V
Weight	W
Young's modulus of elasticity	E

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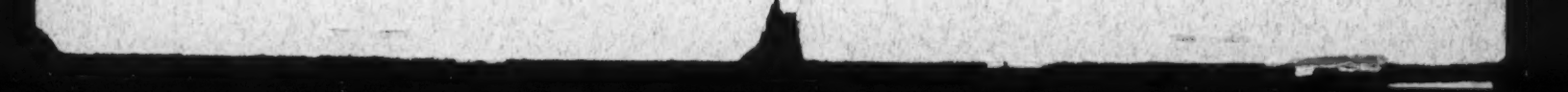

The Bulletin of the Society for the Promotion of Engineering Education

PUBLICATION COMMITTEE

John F. Hayford, Milo S. Ketchum, F. L. Bishop

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The Society comprises about fifteen hundred teachers, engineers and other persons interested in technical education and a considerable number of educational institutions.

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